NSIEX+RS 2025
NEGERI SEMBILAN INTERNATIONAL EXPOSITION

HARMONY IN PROGRESS:

INTEGRATING SCIENCE, TECHNOLOGY, AND SOCIAL INNOVATION FOR SUSTAINABLE DEVELOPMENT GOALS

e-Book of Extended Abstract
Negeri Sembilan International (NSIEx) & Research Symposium
2025

YST026 - DEVELOPMENT OF THERMAL INSULATING MATERIALS FROM CORN HUSK FIBRES

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ABSTRACT

The demand for sustainable materials in textiles has driven interest in natural fibres with thermal insulation properties. Corn husk, a biodegradable agricultural by-product, is often discarded despite its potential value. This study explores corn husk fibres as a thermal insulation material. Collected husks were cleaned, chemically treated with sodium hydroxide or sulfuric acid, processed into nonwoven sheets, and tested for surface appearance, thickness, areal density, and heat retention. Results showed that the untreated sample had the greatest thickness and best heat retention, while 5% NaOH treatment produced the best fibre separation and compaction. Strong acid treatments weakened fibres and reduced insulation performance. These findings highlight corn husk fibres as a viable eco-friendly alternative to synthetic insulators.

Keywords – Corn husk, Eco-friendly, Sustainable materials, Thermal insulation

INTRODUCTION

Growing environmental awareness has driven industries to seek renewable, biodegradable alternatives to synthetic materials. In textiles and construction, there is particular interest in eco-friendly materials that provide thermal insulation while reducing environmental impact. Agricultural waste fibres are promising candidates due to their abundance, low cost, and sustainability.

Corn husks, the outer leaves protecting corn cobs, are produced in large quantities worldwide, with about 140 million tonnes generated annually. Despite this, they are often discarded or openly burned, contributing to air pollution, especially in rural farming areas. In Malaysia, agricultural biomass production is high, yet corn husks remain underutilised. While natural fibres such as jute, flax, and coconut husk have been studied for insulation, corn husks have received less attention despite their low thermal conductivity, durability, and structural stability. This study investigates the potential of corn husk fibres as a sustainable material for textile-based thermal insulation, highlighting opportunities to transform agricultural waste into high-value products, reduce reliance on synthetic insulators, and promote a circular economy.

OBJECTIVES

i. To develop thermal insulation materials from corn husk fibres.
ii. To assess the thermal insulating properties of the fabricated nonwoven materials from corn husk fibres.

DESCRIPTION OF THE PROJECT

Corn husks were collected from local markets in Kuala Pilah, washed, shredded, and dried to remove impurities and reduce moisture. They were then treated with sodium hydroxide (NaOH) or sulfuric acid (H_2SO_4) at varying concentrations to break down non-cellulose components and improve fibre quality. The fibres were mixed with a binder (sodium alginate, glycerine, and distilled water) and formed into nonwoven sheets, which were cross-linked with calcium chloride ($CaCl_2$) for added strength before oven drying.

The materials were tested for surface appearance (microscopic observation), weight, thickness, and heat retention. Surface appearance assessment identified fibre separation and surface smoothness, thickness and weight tests gauged structural and heat-trapping properties, and the heat retention test evaluated the material's ability to maintain warmth over time.

Figure 1: Image of nonwoven sheet samples; a – untreated, b – treated with 3% NaOH, c – treated with NaOH 5%, d – treated with H_2SO_4 7% and e - treated with H2SO4 10%.

Figure 1 above shows the nonwoven insulation sheets produced. The five insulation sheet samples – untreated, NaOH-treated (3% and 5%), and H_2SO_4-treated (7% and 10%), showed distinct differences in fibre structure, thickness, density, and heat retention.

Microscope observations revealed that 5% NaOH produced the smoothest, best-separated fibres, while strong acid treatments caused surface damage and weakened structures. Areal density was highest in the 5% NaOH sample, indicating tighter compaction, whereas the untreated sample was the bulkiest with the lowest density. In terms of thickness, the untreated sample was the thickest (15.32 mm), followed by moderate thickness in 7% H_2SO_4, while the 10% H_2SO_4 sheet was the thinnest due to fibre degradation.

Heat retention tests showed that the untreated sample performed best, with the smallest temperature drop (54°C) after 30 minutes, mainly due to its bulky structure trapping more air. Treated samples retained less heat, with the 10% H_2SO_4 sample performing worst (65°C drop) as excessive acid weakened fibres and reduced thickness. Statistical analysis indicated that thickness had a moderate effect on heat retention, while areal density had little impact. Overall, fibre condition and sheet thickness were more critical to thermal insulation performance than weight alone, with moderate alkaline treatment offering the best balance between structure and processability.

NOVELTY

This project introduces the use of corn husk fibres, a widely available but underutilised agricultural waste, as a sustainable raw material for textile-based thermal insulation. It uniquely compares the effects of different chemical treatments on fibre quality, structure, and heat retention, identifying moderate alkaline treatment as the optimal method to balance processability and insulation performance.

CONCLUSION

Corn husk fibres show strong potential as a sustainable thermal insulation material, with performance driven mainly by fibre condition and thickness. Moderate alkaline treatment, particularly 5% NaOH, achieved the best balance between fibre quality and insulation efficiency, while strong acid treatments degraded performance. This approach offers an eco-friendly alternative to synthetic insulators and supports the circular economy. As this is a preliminary laboratory-scale study, further research using advanced testing methods is recommended.